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Cobalt-Copper Nanoenabled Electrodes Enhance Selective Reduction of Nitrate to Ammonia for Resource Recovery

Background

Electrocatalytic nitrogen fixation could enhance the sustainability of global ammonia production. However, overcoming the high energy barrier to break the triple bond of dinitrogen (N2) has proved to be a challenge.

Electrochemical reduction of nitrate (ERN) is an alternative solution, but ERN currently relies on platinum group metals (PGMs) as electrocatalytic materials. There has been some research focused on the study of platinum and palladium as noble cathodic PGMs due to their high electrocatalytic activity and corrosion resistance, but there have been issues with using these PGMs at large scale due to their high cost, and their endangered nature. There is a need to identify alternative catalytic materials to ensure further development of ERN as dual water treatment and resource recovery technology. Bimetallic electrodes can synergistically boost the performance of abundant transition metals through the formation of hybrid metal interfaces as catalytic sites.

Invention Description

Researchers at Arizona State University and CNRS have developed copper-cobalt nanoenabled electrodes that enable nitrate reduction using selective electrochemical means. The synergistic behavior between copper and cobalt nano-interfaces improves ERN performance and selectivity toward ammonia production. Electro-synthetic processes allow for the manufacturing of these 3D Cu-Co3O4 electrodes solely based on the use of earth-abundant materials. The copper-cobalt interfaces demonstrated superior electrocatalytic outcomes including ERN kinetics conversion, product selectivity, and electrode stability.

Potential Applications

- Denitrification for water treatment
- Decentralized ammonia production
- Waste revalorization

Benefits & Advantages

- Faster and highly selective reduction of nitrate
- Surpasses performance of conventional platinum group electrocatalysts
- Sustainable and less expensive (does not rely on the use of platinum or precious metals)
- Compact units that can be deployed as decentralized treatment devices
- Can be operated off-grid through the use of solar energy

- Transforms nitrate into an added value product